Econometric Analysis of the Effects of Intermodal Competition in Virginia

A. Background

In this appendix, I describe the econometric model I used to analyze the relationship between Verizon's residential access lines, the availability of intermodal alternatives, and several economic variables. The underlying purpose of the analysis is to explain observed losses in Verizon residential lines over time and across counties and to determine the extent to which increased intermodal competition results in reductions in Verizon's residential lines, holding constant other factors that also affect the number of Verizon's residential lines, *i.e.,* demand and supply characteristics. Put another way, this analysis attempts to answer the question whether intermodal services are effective substitutes for Verizon's services.

B. Data

I used county level data (including counties and independent cities) because (i) the wire center level is too small to obtain sufficiently accurate data on some of the explanatory demographic variables; and (ii) the MSA level data may not allow enough observations to obtain statistically significant parameter estimates. I obtained data for the Verizon portion of the 96 counties in which it has a presence in Virginia for the variables of interest for year-end 2003 through March 2006. This type of dataset, with both time and geographic dimensions, is known as "panel" data where the cross sectional units are those parts of Virginia counties where Verizon provides residential service. For 2003 through 2005, the data are as of the end of the year and for 2006 the data are as of the end of March.

C. Variables

Verizon Residential Lines/Households (VZL) – This variable measures Verizon residential lines per household and is used as the dependent variable in the econometric analysis. The data were obtained from Verizon, which assigned each of its wire centers to the county in which the switch serving the wire center is located.[1] Data on households per county were obtained from the Census Bureau.

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[1] Lines in a wire centers may span more than one county—*e.g.*, the switch serving wire center A is in county A, but some of the lines in wire center A may be in county B or county C. For purposes of this analysis, all lines in the wire center were assigned to the county where the switch serving the wire center resides. This can introduce a measurement error in the dependent variable because in some instances the number of Verizon residential lines assigned to a county is greater than the actual line count in that county while in other instances it is less than the actual count. There is no reason to believe, however, that Verizon's assignment methodology leads to systematic errors—*i.e.*, either consistently over or under counting of lines in a county and thus the measurement error should not bias my results. Nevertheless, as described below, I have modified the data set to eliminate some extreme values in the data set that do not

Cable Telephone Availability/Households (**CVA**) – This variable measures the percentage of homes able to obtain cable telephone service. Because cable telephone offerings were relatively new during the period in question, *e.g.*, only 12 counties accounting for less than one-quarter of the households could subscribe to cable telephone by the end of 2003 and because service demand often grows over time, we multiplied the percentage of homes with access to cable telephony by a measure of the length of time the service had been available in the area.[2] Thus, the variable accounts for the fact that cable subscribership tends to grow (and Verizon's lines tend to decline) over time as potential customers become more aware of the alternative offering. The sign and coefficient on this variable provide information on the extent to which the availability of cable telephony service reduces Verizon's residential lines by offering customers a substitute service. I obtained data on households with cable telephony available for each time period except March 2006. I estimated the data as of March 2006 by averaging the values reported at the end of 2005 and the end of June 2006. This was done in order to maintain a common time period for all variables. The data were obtained from Warren Communications News, *Cable Fact Book,* GIS Format.

Cable Modem Availability/Households (**CMA**) – This variable measures the percentage of homes in a county that are able to obtain cable modem service. The rationale for including this variable is that cable modem availability is related to the potential for customers to replace dial-up lines with broadband Internet access, and it also serves as a measure of the availability of "over-the-top" VoIP services such as Vonage. The March 2006 observations of CMA were estimated by averaging the values reported at the end of 2005 and the end of June 2006. The data were obtained from Warren Communications News, *Cable Fact Book,* GIS Format.

Cellular Towers (CTA) –This variable measures the number of cellular towers deployed in a locality. This variable provides a measure of the availability of wireless services and it may be a proxy for subscribers, since subscriber data are not available at such a discrete level. The data were obtained from FCC Antenna Structure Registration.

CLEC Lines/Households (CLEC) –This variable measures the number of access lines provided by CLECs in a given county and a given year. CLEC lines are calculated as the sum of resale, wholesale, and facilities-based lines as measured by E911 listings. The data were obtained from Verizon.

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likely correspond to the real world but rather are the likely result of the manner in which the variable has been measured.

[2] Specifically, the measure of duration was the square root of the number of months between the midpoint of the year in which cable telephone service became available in the county and the end of the period in question. For example, if cable telephone service were available to 50 percent of a county's households in 2003 and service started in 2001, we estimated duration to be 30 months. The variable used in the model would therefore equal $30^{0.5} \times 0.5 = 2.74$.

Inverse Population Density (Pop-Den) – This variable is calculated as each county's area divided by its population. The variable serves as an indicator of how costly it is to provide service in each county. Since telecommunication costs, especially for loops, are generally higher and the number of potential customers lower in areas with lower population densities, there is likely to be less competitive entry and, therefore, smaller line losses for Verizon. The data were obtained from the Census Bureau and from Rand McNally.

Employment (Employment) – This variable measures the number of employed persons. The variable controls for differences in demand characteristics by county. The data were obtained from the Bureau of Labor Statistics and Dunn & Bradstreet.

Basic Local Exchange Rates (BLETS) – This variable measures average nominal local exchange rates. The variable was constructed from wire center level data by taking a weighted average of the BLETS rates for the wire centers within a given county in a given year. We used total wireline lines per wire center as the weights. The data were obtained from Verizon.

D. Descriptive statistics

Table A1 below presents the descriptive statistics for the variables used in the econometric analysis. During the 2003-2006 time period, the number of CLEC lines per household remained essentially constant in the low **[BEGIN CONFIDENTIAL]**

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In contrast, the number of Verizon lines per household declined steadily from about 92 lines per 100 households in 2003 to only 76 lines per 100 households by March 2006. The percentage of households able to subscribe to cable telephony service increased from 23 percent during in 2003 to 54 percent by March 2006. The percentage of households able to subscribe to cable modem services (and thus have access to VoIP) increased moderately from 81 to 88 percent during the same time period. The number of employed persons increased over the period, while the average price for basic local exchange service increased from $14.15 in the first two years to almost $15.00 per month at the end of the period.

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I deleted several counties from the regression database because of an apparent mismatch between the line data from Verizon and demographic data. In particular, because the maximum Verizon residential lines per household in a given county in a given year was 6.38 and the maximum CLEC residential lines per household in a given county in a given year was 1.34, I concluded that—as discussed in footnote 10—the methodology used to assign lines to a particular county was likely responsible for these anomalous results. As a result I modified the data set to eliminate such outliers, where the sum of Verizon and CLEC residential lines per household exceeded the average value of this sum over all of the counties by more than one standard deviation.[3] As a result, five counties were removed from the original set of 96 (six including one dropped for lack of CLEC data). Table A2 presents descriptive statistics for the total sample and the restricted sample for this variable.[4]

Table A2
Total Lines per Household Statistics

	Obs.	Mean	Std. Dev.	Min	Max
Total Sample	384	1.20	0.54	0.46	6.38
Restricted Sample	360	1.13	0.18	0.76	1.70

Note: Restricted sample also includes the effect of dropping Virginia Beach City.

E. Estimation of the econometric model

The data for this analysis consist of cross-sectional/time series (panel) data. I use the following equation to estimate the values for the parameters of interest:

$$y_{it} = \alpha + x_{it}\beta + v_i + \varepsilon_{it} \qquad (1)$$

where y_{it} is the dependent variable VZL, Verizon residential lines per households; β is a vector of coefficients to be estimated; x_{it} is a set of exogenous variables (the availability of intermodal alternatives and the demand and supply control variables); α is constant; v_i are county-specific variables that differ among counties but remain constant for any particular county over the four yearly observations in the sample; and ε_{it} is the residual, assumed to be independent and identically distributed (i.i.d.).

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[3] I also removed one city for which Verizon has lost the E911 database contract so that CLEC line data is unavailable in the last two periods.

[4] Unlike Table A1, the averages in Table A2 are simple averages

The model can be specified as either a fixed effects or random effects model. A Lagrange multiplier test and a Hausman specification test indicated the presence of time-invariant unobservable effects correlated with included explanatory variables, so that generalized least squares estimates of a random effects model would be biased and inconsistent.[5] As a result, I relied on the fixed-effect models whose estimates are shown in Table A3.

Table A3
Robust Fixed Effects Model

CVA	-0.017899 **
	(3.06)
CMA	-0.0116692
	(.88)
CTA	-0.0107794 **
	(4.92)
CLEC	-0.8600526 **
	(4.66)
Pop_Den	13.71501
	(1.10)
Employment	-0.0016678
	(1.44)
BLETS	-0.053481 **
	(10.39)
α (Constant)	1.929292 **
	(9.83)
Observations	360
R-squared	0.6875

Robust t-statistics in parentheses.
* Significant at 5%.
** Significant at 1%.

In general, the explanatory variables are highly statistically significant and have plausible signs.[6] The indicators of competition from other sources—cable telephone availability, cell tower deployment, and CLEC lines variables—imply that as competitive opportunities increase, customers opt for these competitive services in lieu of Verizon

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[5] See, *e.g.*, J.A. Hausman and W.E. Taylor, "Panel Data and Unobservable Individual Effects," *Econometrica*, 49 (1981), pp. 1377-1398.

[6] The one exception is the cable modem availability variable. Although its coefficient is negative as expected, it is not statistically significant. This outcome may have been due to the fact that cable modem service was already widely available at the start of our analysis period; thus, the observed variations in this variable may have been too small to yield statistically significant results. (See Table A1 above.).

services, leading to Verizon line losses. The supply and demand explanatory variables are significant and plausible as well: Verizon retains a higher level of lines in counties with lower population density, but experiences greater line losses in association with higher employment. This may be due to greater competitive entry in these potentially more lucrative areas. Finally, as would be expected, Verizon line loss increases in response to an increase in the price of basic service. As discussed in more detail in my testimony, application of my regression shows that as intermodal service availability grows over time and across areas, Verizon lines decline, all else equal. This confirms that intermodal services are effective substitutes for Verizon wireline services in Virginia.